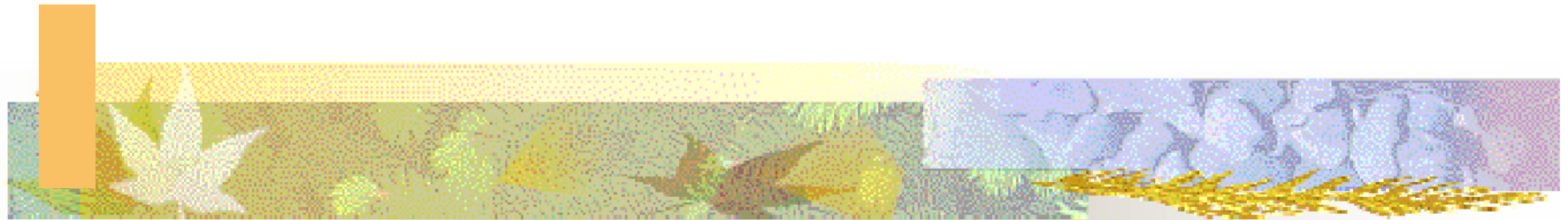


# MERCURY STRATEGY OVERVIEW



Shelly Wilson, Environmental Quality Control

Robbie Brown, Bureau of Air Quality

James B. Glover, Ph.D., Bureau of Water

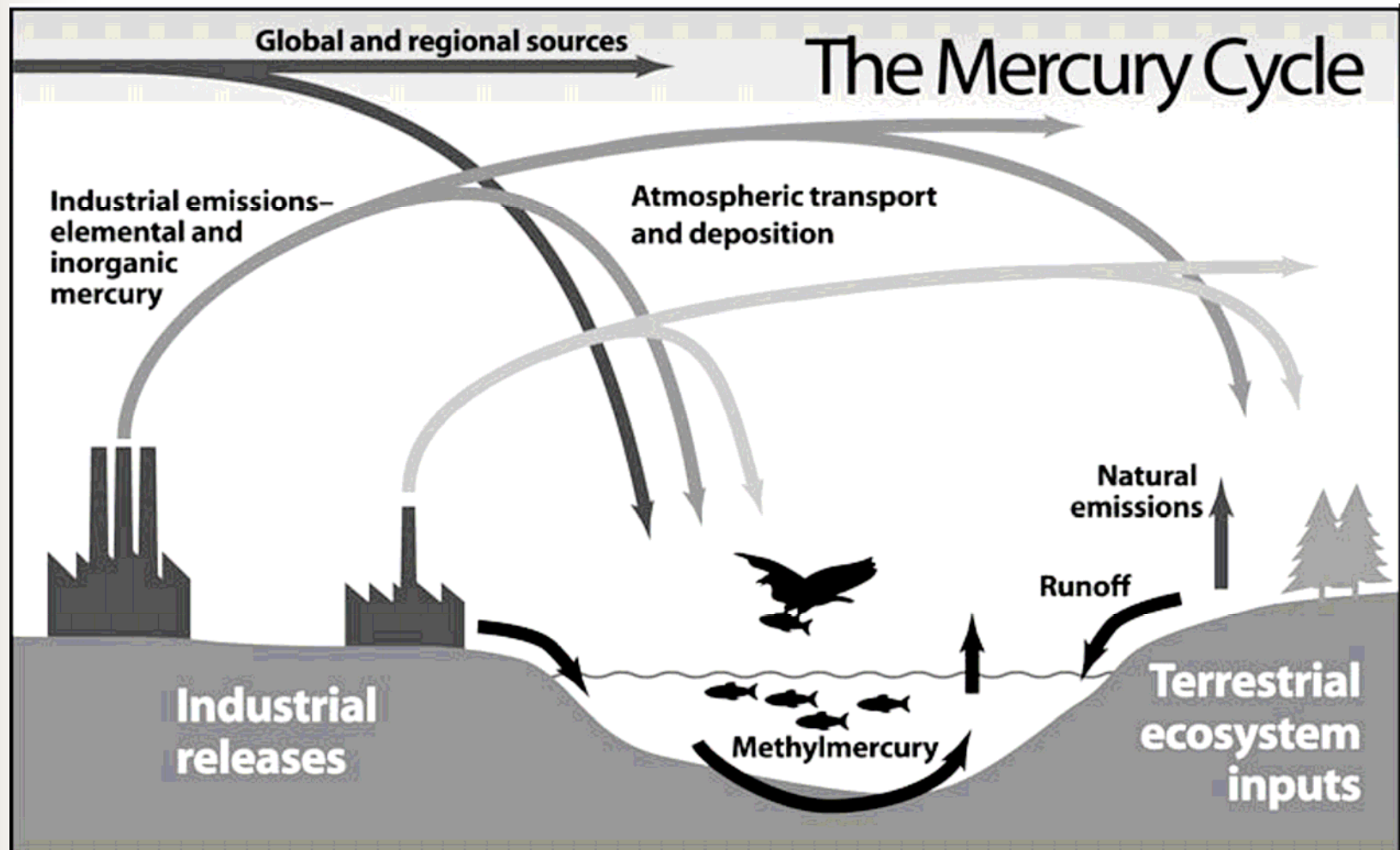
Rodney Wingard, Bureau of Land and Waste



# MERCURY STRATEGY

- DHEC is developing a mercury risk reduction strategy.
- Goal: Collaborative ways for public, industry, interested groups and government to reduce risk
- Currently in draft stage
- We are looking for your ideas, input.

# MERCURY CYCLE





# EXPOSURE RISKS

- **Environmental** – primarily through fish consumption
- **Mercury products** – through handling and disposition (thermometers, thermostats, fluorescent lamps, etc. at home, schools, health facilities and on the job)



# HEALTH EFFECTS

- Impairment of peripheral vision
- Disturbances in sensation, numbness
- Lack of coordination of movement
- Speech, hearing and walking impairment
- Muscle weakness
- Skin rashes
- Mood swings, memory loss and mental disturbances



# PURPOSE OF STRATEGY

- To identify ways that the public, industry, interested groups and government may collectively reduce the risk from mercury exposure
  - Collective responsibility
  - May not yield near term measurable changes
  - Strategy will be living, changing



# BASIC COMPONENTS

- Baseline inventory of emissions
- Monitoring and research
- Reduction
- Measures
- Stakeholder interaction

# Mercury in the Environment: an Air Update



Robbie Brown

The South Carolina Department of Health  
And Environmental Control





# Types/Forms of Hg Emissions

- Mercury (Hg) is a naturally occurring element that is present throughout the environment.
- Elemental Mercury [ $\text{Hg}^{(0)}$ ]
  - ~95% of total Hg in atmosphere
  - Long atmospheric lifetime (~0.5 – 1 year); travels globally
- Oxidized Mercury [ $\text{Hg}^{(\text{II})}$ ]
  - Small percent of total Hg in atmosphere
  - Short atmospheric lifetime (~1 week or less): more local and regional distribution
- Particulate Mercury [ $\text{Hg}^{(\text{p})}$ ]
  - Small percent of total Hg in atmosphere
  - Moderate atmospheric lifetime (1-2 weeks); more local and regional distribution



# Hg Air Pollutant Classification

- Federal

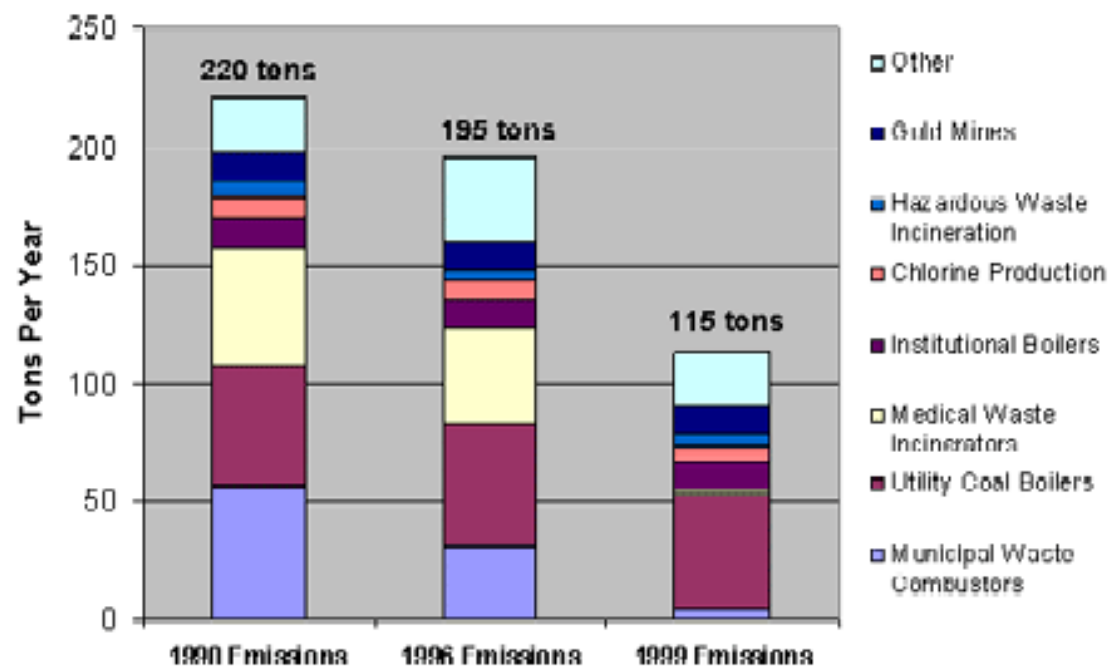
- Hazardous Air Pollutant (HAP) under Section 112(b) of the Clean Air Act

- State

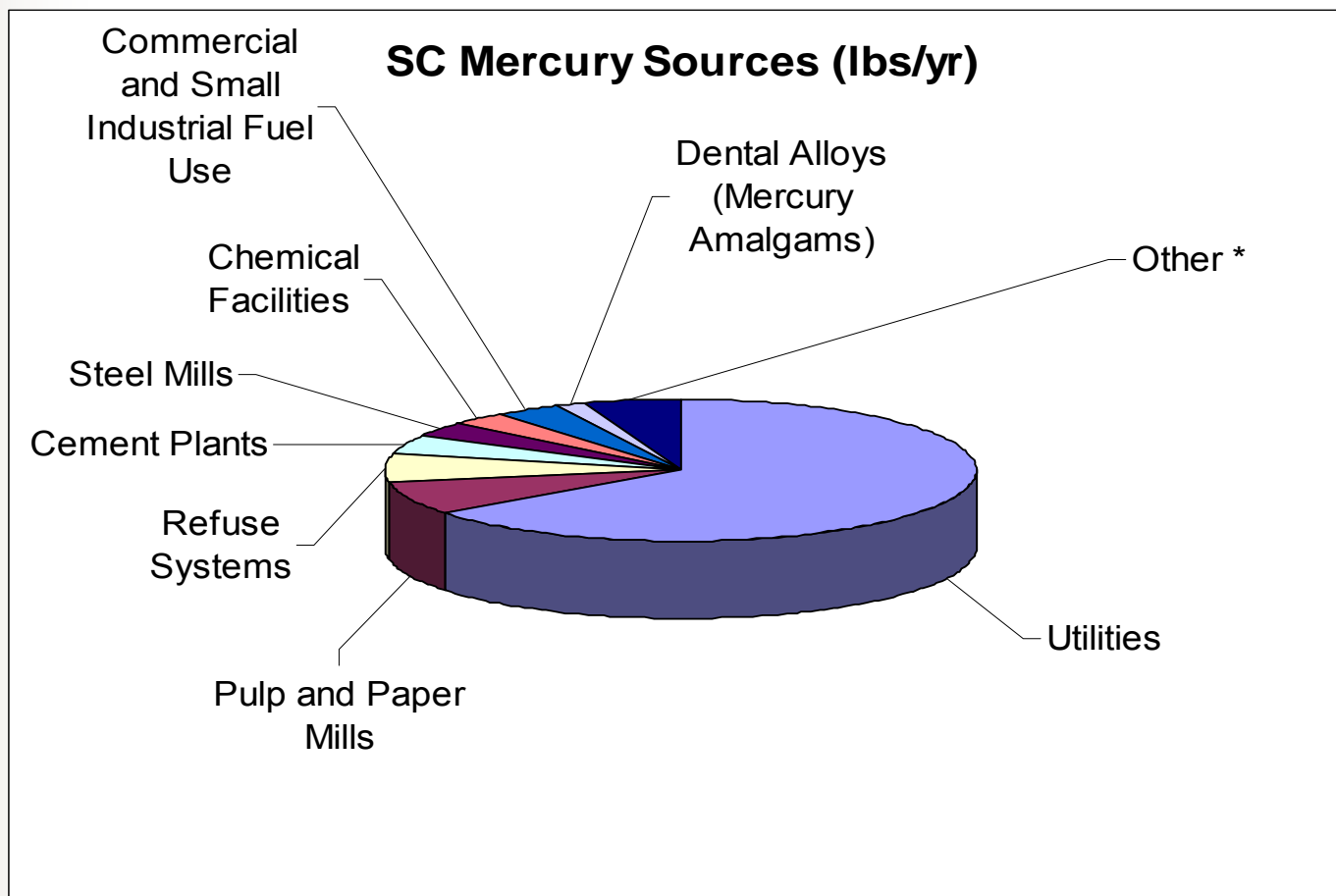
- Toxic Air Pollutant (TAP) under State Air Toxics Regulation (Standard No. 8)

# US Hg Emissions

## U.S. Emissions of Human-Caused Mercury



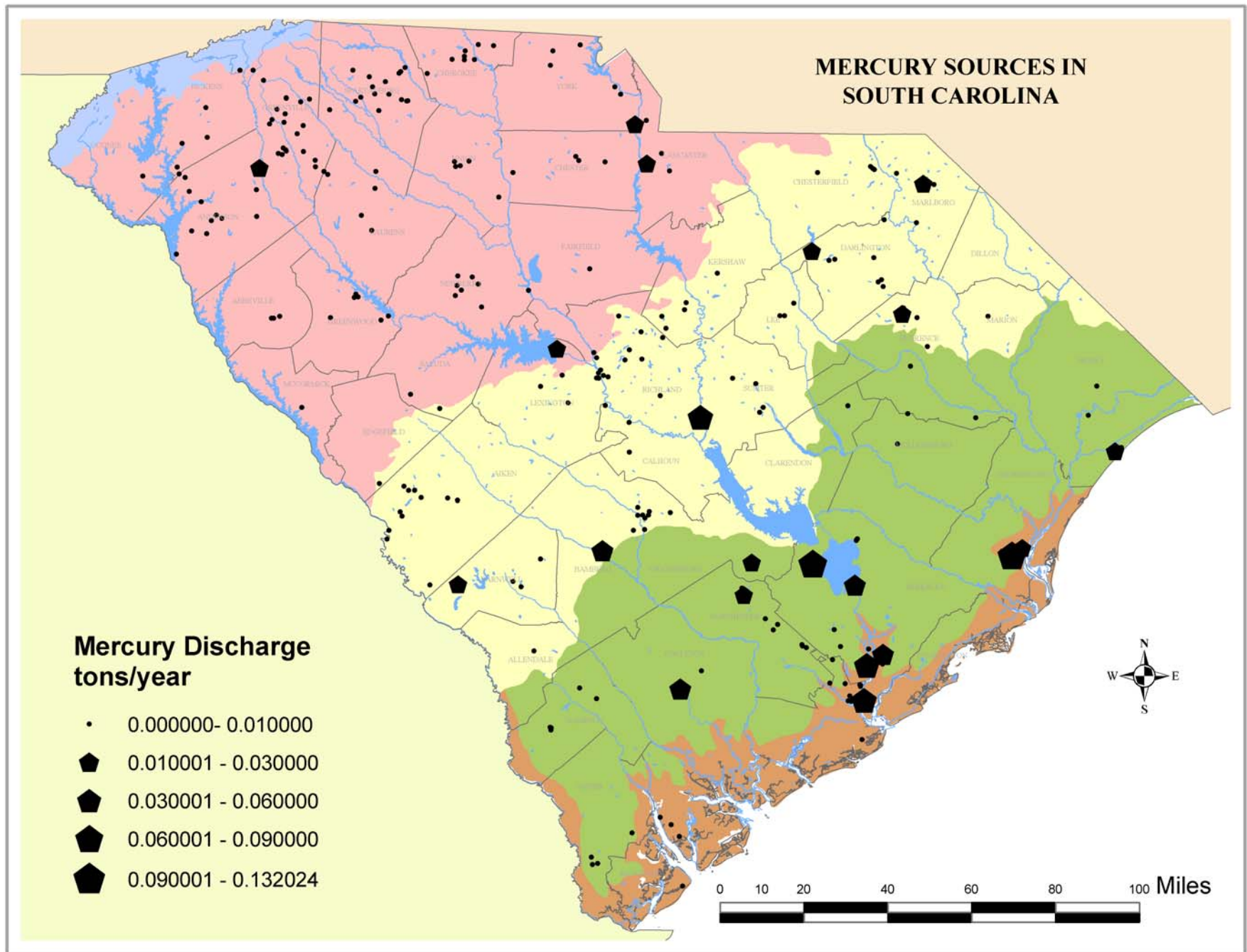
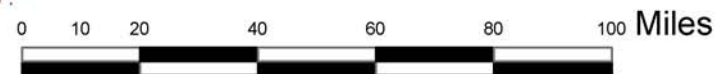
# SC Hg Emissions



# MERCURY SOURCES IN SOUTH CAROLINA

## Mercury Discharge tons/year

- 0.000000 - 0.010000
- ◼ 0.010001 - 0.030000
- ◼ 0.030001 - 0.060000
- ◼ 0.060001 - 0.090000
- ◼ 0.090001 - 0.132024





# Controlling Hg (add-on controls)

- Co-benefits of sulfur dioxide (SO<sub>2</sub>) and nitrogen oxide (NO<sub>x</sub>) control devices
  - Scrubbers for SO<sub>2</sub>
  - Selective Catalytic Reduction (SCR) for NO<sub>x</sub>
- Particulate Matter (PM) control devices
  - Electrostatic precipitators (ESP)
  - Baghouses
- Scrubber+SCR+ESP = 90% Hg control



# Controlling Hg

- Fuel selection (solid, liquid, gas)
  - Hg content
  - Mining region (coal type)
- Boiler design
  - Sub-critical, supercritical, ultra-supercritical
  - Integrated Gasification Combined Cycle (IGCC)
- Activated carbon injection
  - Emerging technology



# Air Regulations/Standards

## ■ Federal

- Industrial Boilers & Process Heaters
- Hazardous Waste Incineration
- Municipal Solid Waste Combustion
- Clean Air Mercury Rule (CAMR) -Coal-fired utility boilers

## ■ State

- Waste Combustion & Reduction (Standard No. 3)
  - Incinerators, combustors, etc.
- Toxic Air Pollutants (Standard No. 8)
- Enforce federal standards



# Recently Vacated Federal Rules

- Boiler Maximum Achievable Control Technology (MACT)
  - Hg limits for solid and liquid fired units
- Clean Air Mercury Rule (CAMR)
  - Hg limits for new utility boilers
  - Hg “cap & trade” program for existing utility boilers
  - Hg monitors on all utility units



# Measuring Hg Emissions

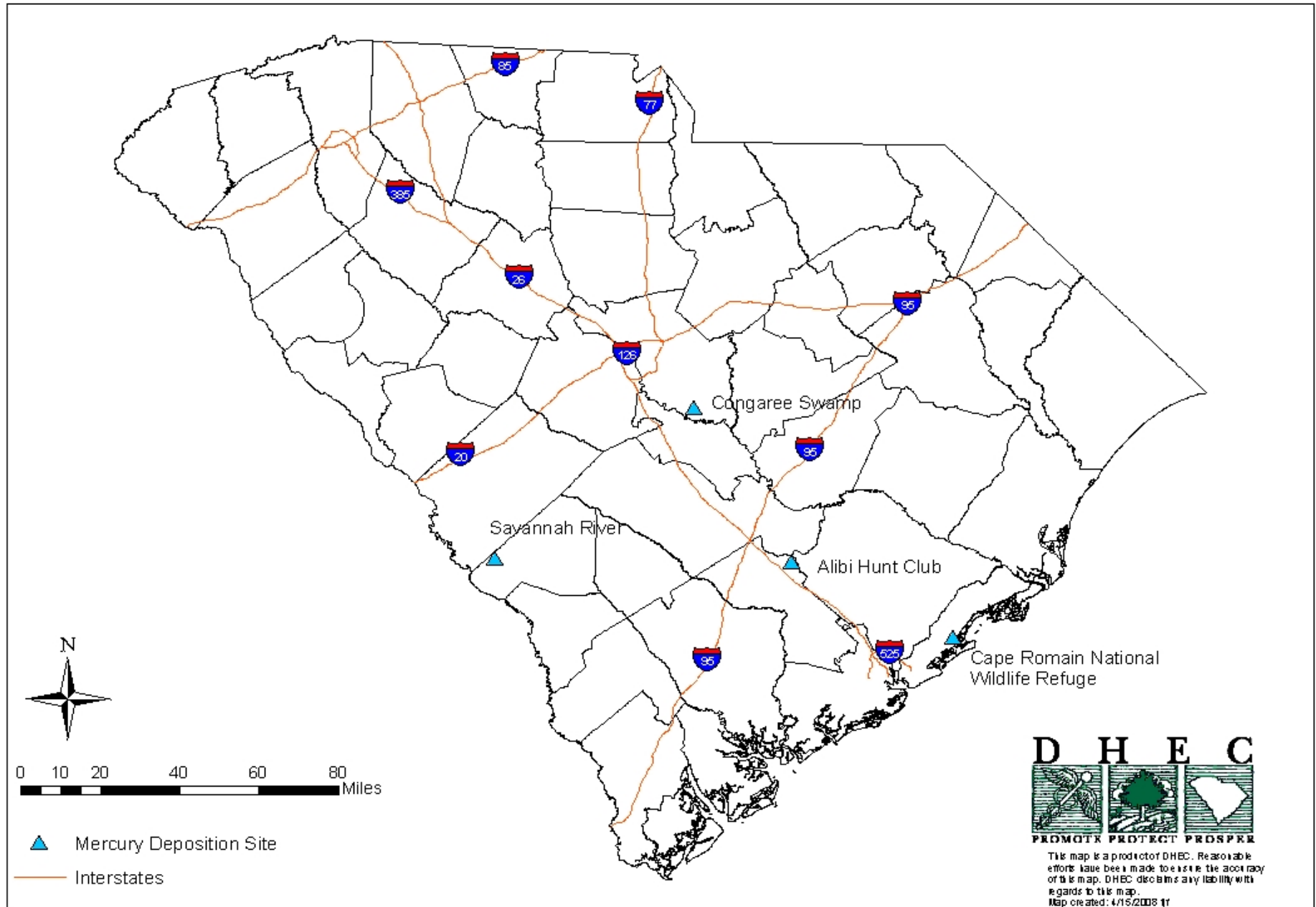
- Stack testing
- Emissions factors (estimates)
- Continuous emission monitors (CEM)
- Ambient monitoring



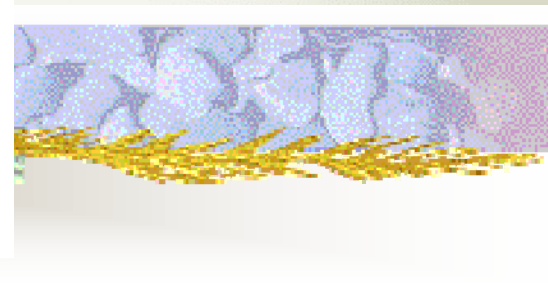
# Hg Deposition Debate

- Where does Hg fall after exiting the stack?  
How far does it travel?
- Is most Hg in an area from local, regional, or global sources?
  - Impact of Hg traveling from other states, Asia, Europe
- Many studies – conclusions vary widely (no consensus), more studies needed

# South Carolina Mercury Deposition Monitoring Network



# Mercury in the Environment: a Water Update



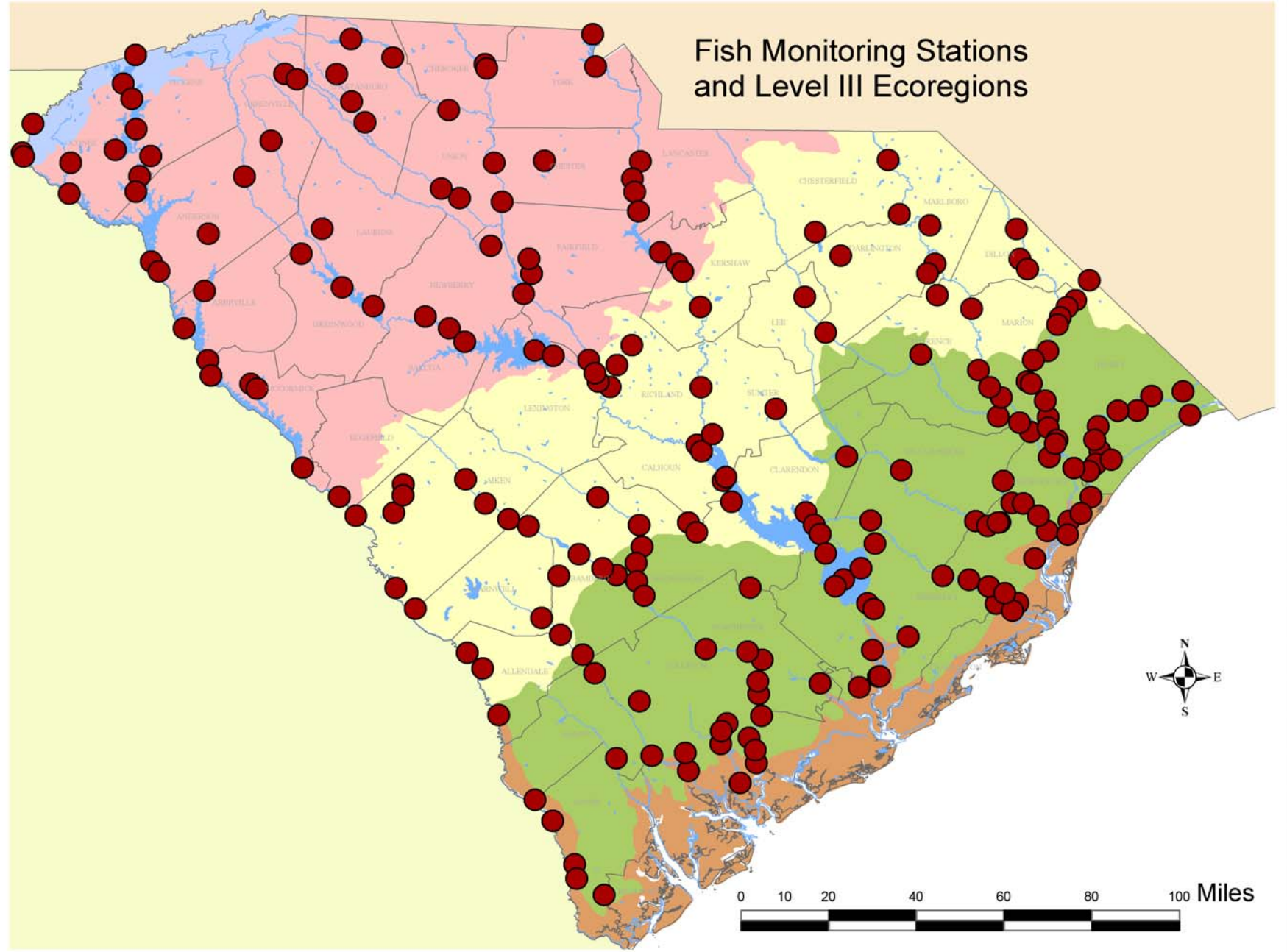
James B. Glover, Ph.D.

The South Carolina Department of Health  
And Environmental Control





## Fish Monitoring Stations and Level III Ecoregions



**SOUTH CAROLINA - YEAR 2006  
FISH CONSUMPTION ADVISORY AREAS**

∩ Mercury Advisory  
 ∩ PCB Advisory  
 ∩ No Advisory - Sampled  
 ∩ No Advisory - No Data  
 ∩ Coastal Zone Critical Line  
 ■ Mercury advisory for King Mackerel and Swordfish in the South Atlantic Ocean  
 □ County Lines

**D H E C**  
 FROM OUR PROTECT PROSPER  
 South Carolina Department of Health and Environmental Control



# Sample Collection



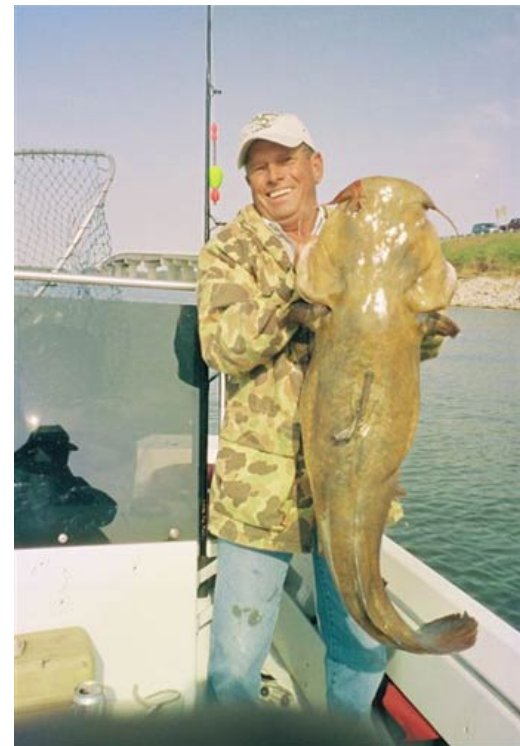
# What Species are Collected?

- Target piscivorous species
- Largemouth bass (*Micropterus salmoides*)
- Bowfin ( *Amia calva* )



- Incidental fish species are collected when available

- Sunfish, catfish, pickerel, etc.





# Level of Advisories for Hg

- Unlimited Consumption ( $< 0.25$  ppm)
- 1 meal per week ( $0.25 - 0.6$  ppm)
- 1 meal per month ( $0.6 - 1.0$  ppm)
- Do No Eat ( $> 1.0$  ppm)
- Women of childbearing age and children are advised not to eat fish from waters with any restrictive advisory



**HEALTH ADVISORY**  
S.C. DHEC has found that some fish from these waters contain high levels of mercury.  
Women who are pregnant or plan to become pregnant soon, nursing mothers, infants, and children under 14 should not eat fish caught from these waters.  
For all others, follow the advice listed below.  
For more information call 1-800-845-0241 or go to <http://www.scdhec.gov/fish>

**ADVERTENCIA SOBRE LA SALUD**  
S.C. DHEC ha encontrado que algunos peces de estas aguas contienen altos niveles de mercurio.  
Las mujeres embarazadas o que estén pensando en quedar embarazadas pronto, madres que estén amamantando, bebés y niños menores de 14 años de edad no deben comer peces que se hayan pescados en estas áreas.  
Para todos los demás personas, siga el consejo que se encuentra a continuación.  
Para más información llame al 1-800-845-0241 o vaya a <http://www.scdhec.gov/fish>






**SOUTH FORK EDISTO RIVER:**  
FROM AIKEN STATE PARK TO EDISTO RIVER

Amount of Fish	Amount of Mercury	Amount of Fish	Amount of Mercury
100 lbs of Catfish	1.0 mg of Mercury	100 lbs of Bass	1.0 mg of Mercury
100 lbs of Crayfish	1.0 mg of Mercury	100 lbs of Trout	1.0 mg of Mercury
100 lbs of Sunfish	1.0 mg of Mercury	100 lbs of Walleye	1.0 mg of Mercury
100 lbs of Yellow Perch	1.0 mg of Mercury	100 lbs of White Perch	1.0 mg of Mercury

For more information call 1-800-845-0241 or go to <http://www.scdhec.gov/fish>

28 12:10PM

# SOUTH FORK EDISTO RIVER: FROM AIKEN STATE PARK TO EDISTO RIVER

1 Meal a Week <i>1 Comida a la Semana</i>	1 Meal a Month <i>1 Comida al Mes</i>	DO NOT EAT ANY <i>NO COMA NADA</i>
 <p>Some Pan Fish/Bream (Bluegill, Redear and Redbreast Sunfish, Warmouth, Black Crappie)</p>		 <p>Flathead Catfish</p>  <p>Pickerel</p>  <p>Largemouth Bass</p>  <p>Bowfin (Mudfish)</p>

If a type of fish is not listed above, it means that there may not be enough data to provide advice or that there are no restrictions. For more information call 1-888-849-7241 or go to <http://www.scdhec.gov/fish>.

Si un tipo de pez no está listado arriba, esto quiere decir que posiblemente no hay suficiente información para dar consejo o no hay restricciones. Para más información llame al 1-888-849-7241 o visite el sitio de red <http://www.scdhec.gov/fish>.





## Factors Affecting Mercury Methylation

### ■ Spatial Controls

- 1. Wetlands
- 2. Presence of anoxic bottom waters
- 3. Flooding
- 4. Drying and Rewetting



# Factors Affecting Mercury Methylation

## ■ Biogeochemical Controls

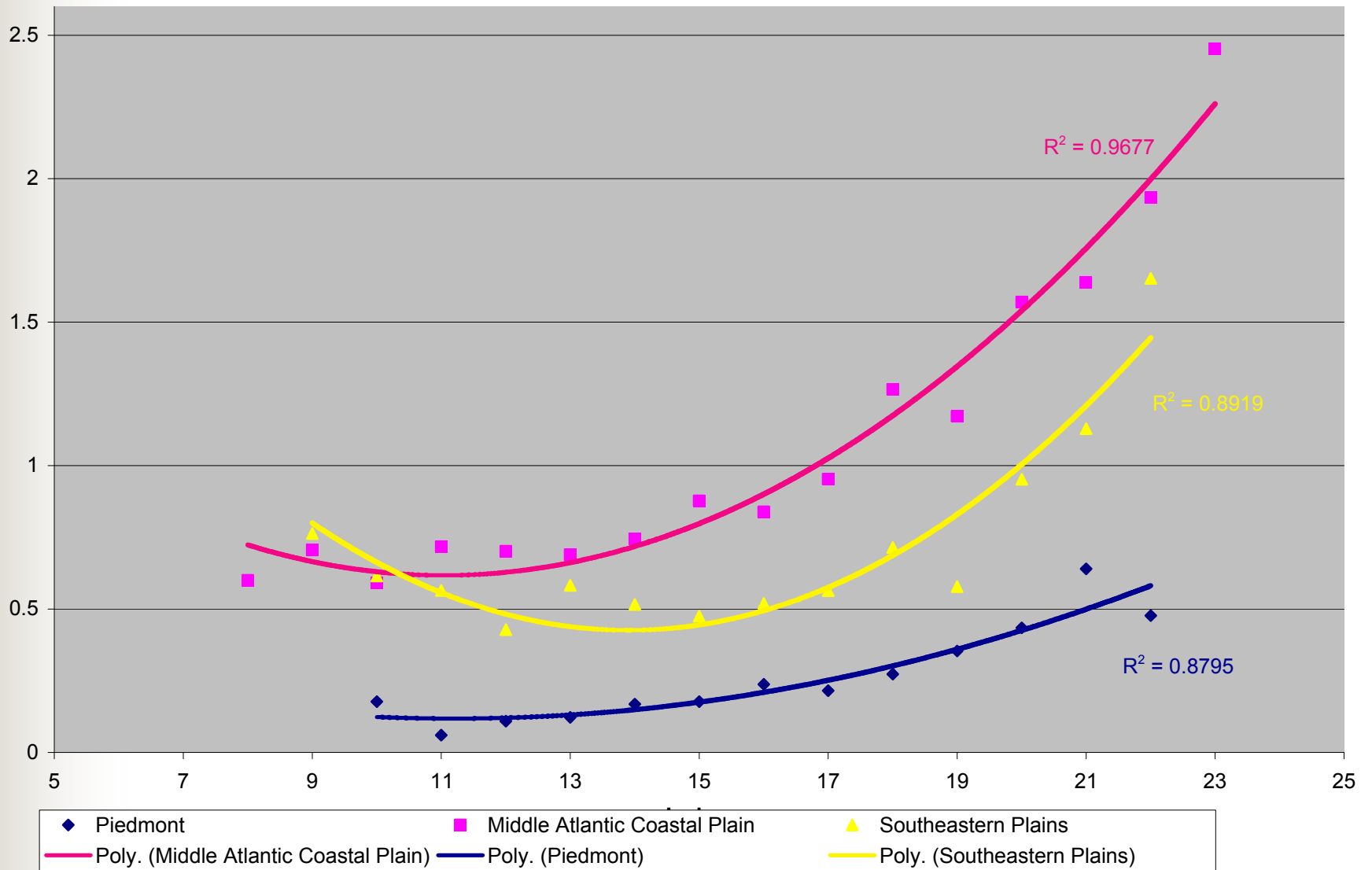
- 1. pH
- 2. Organic Matter
- 3. Sulfur
- 4. Iron



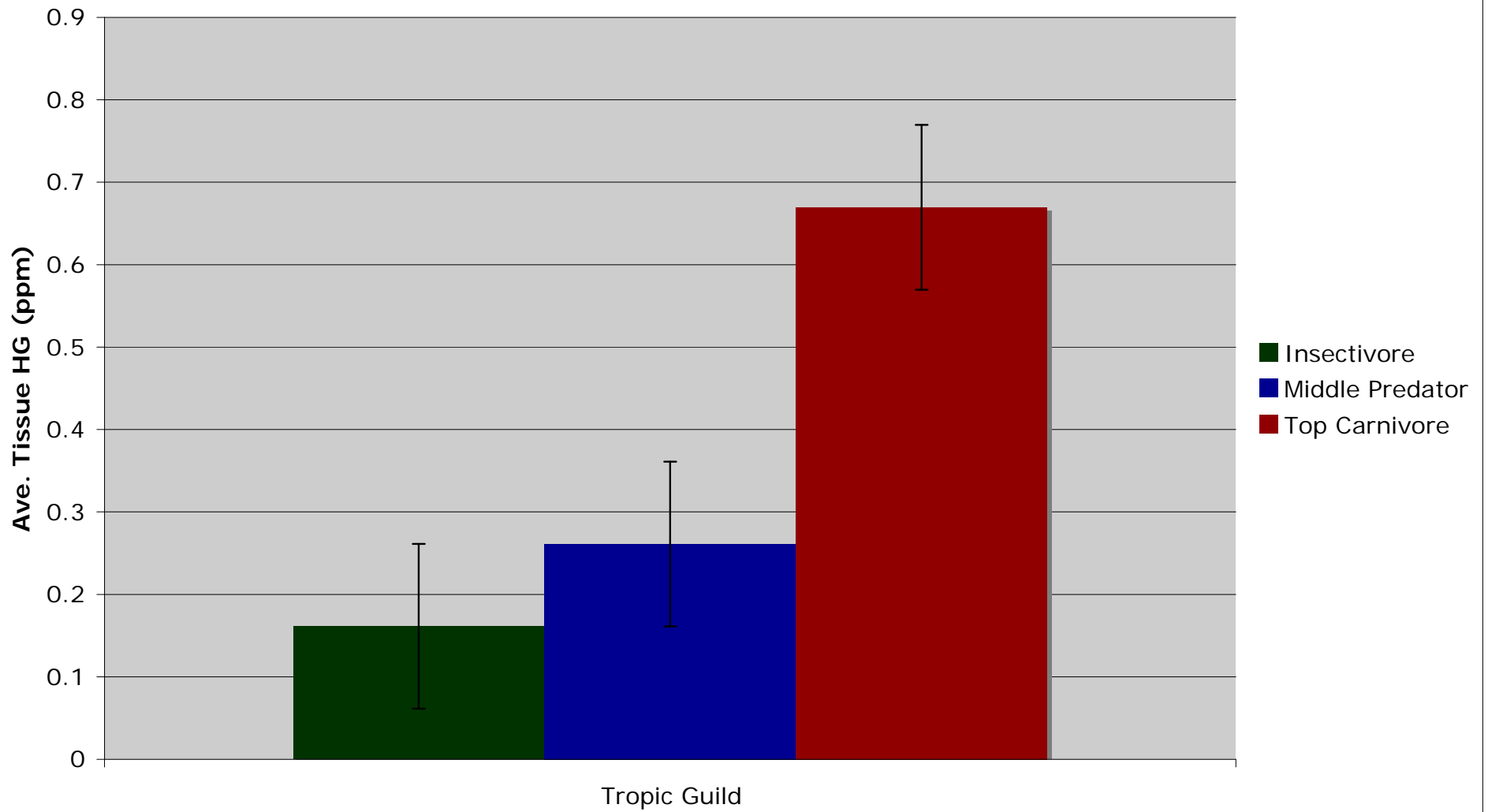
## Biological Variables affecting Hg in Tissue

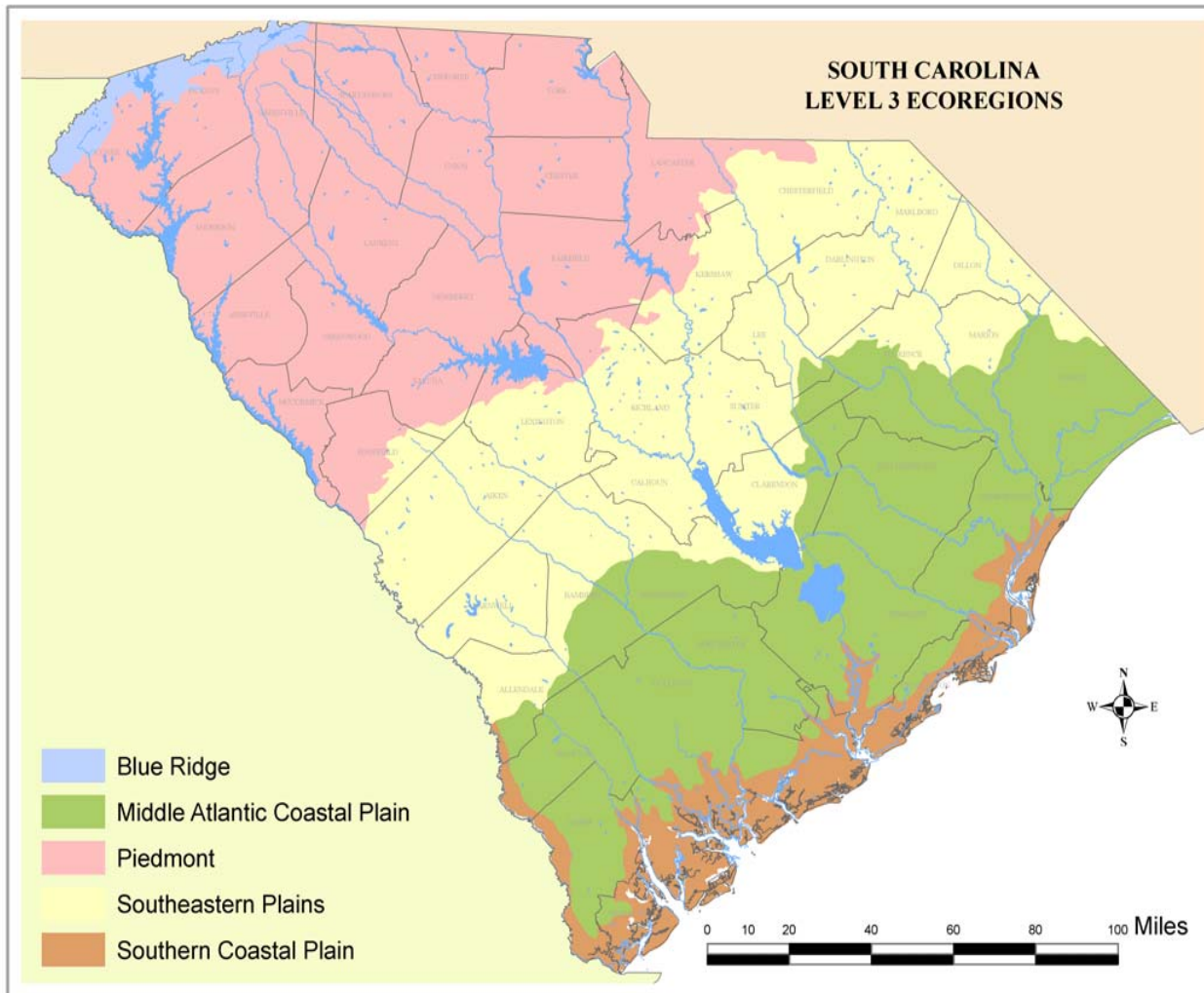
- 1. Feeding Group  
(Predators, Insectivores, Top Level Carnivores)
- 2. Age/Weight/Length
- 3. Tissue Type  
(Skin on Fillet, Whole Fish, Headless Fish)

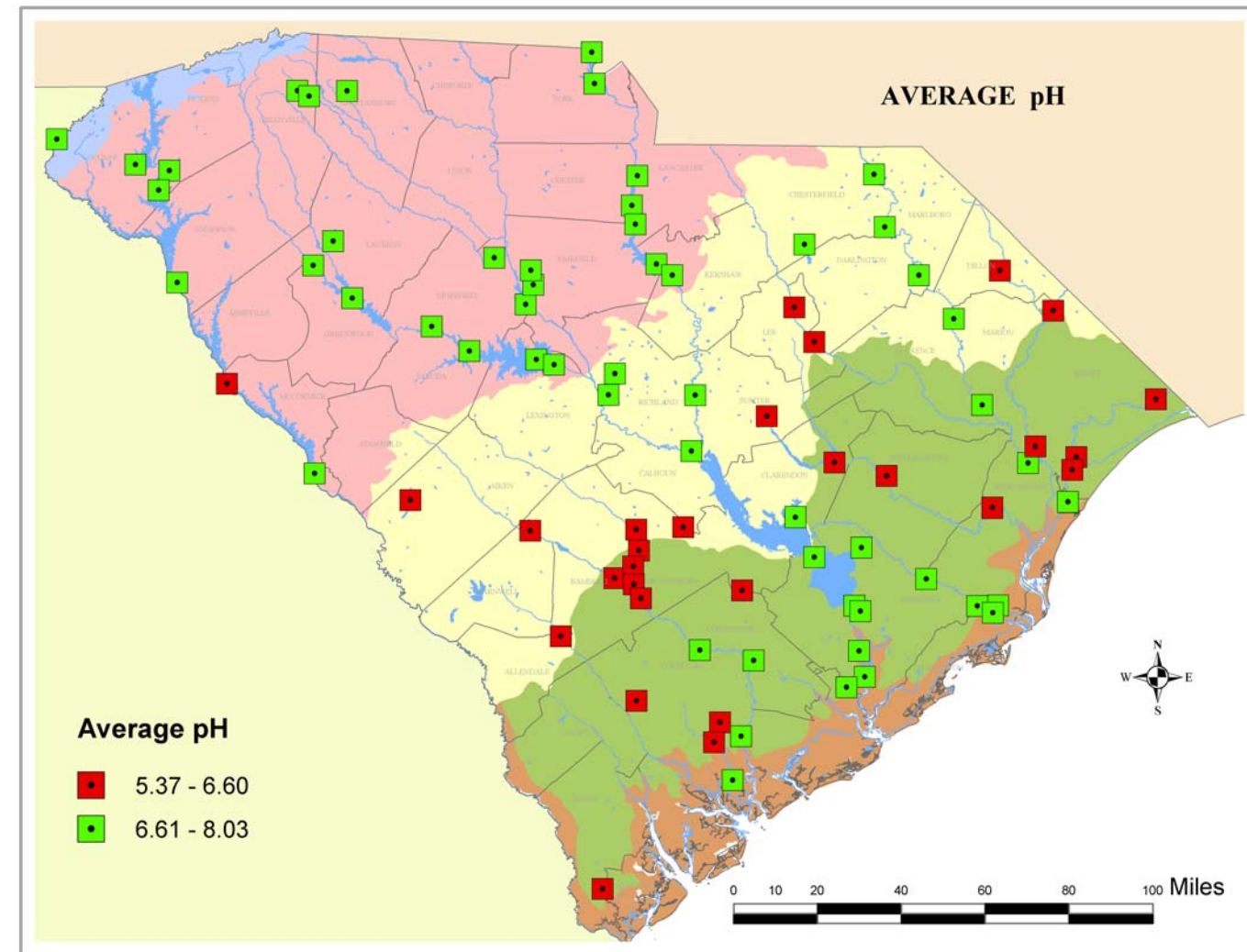
## Average HG Tissue Concentrations for Largemouth Bass



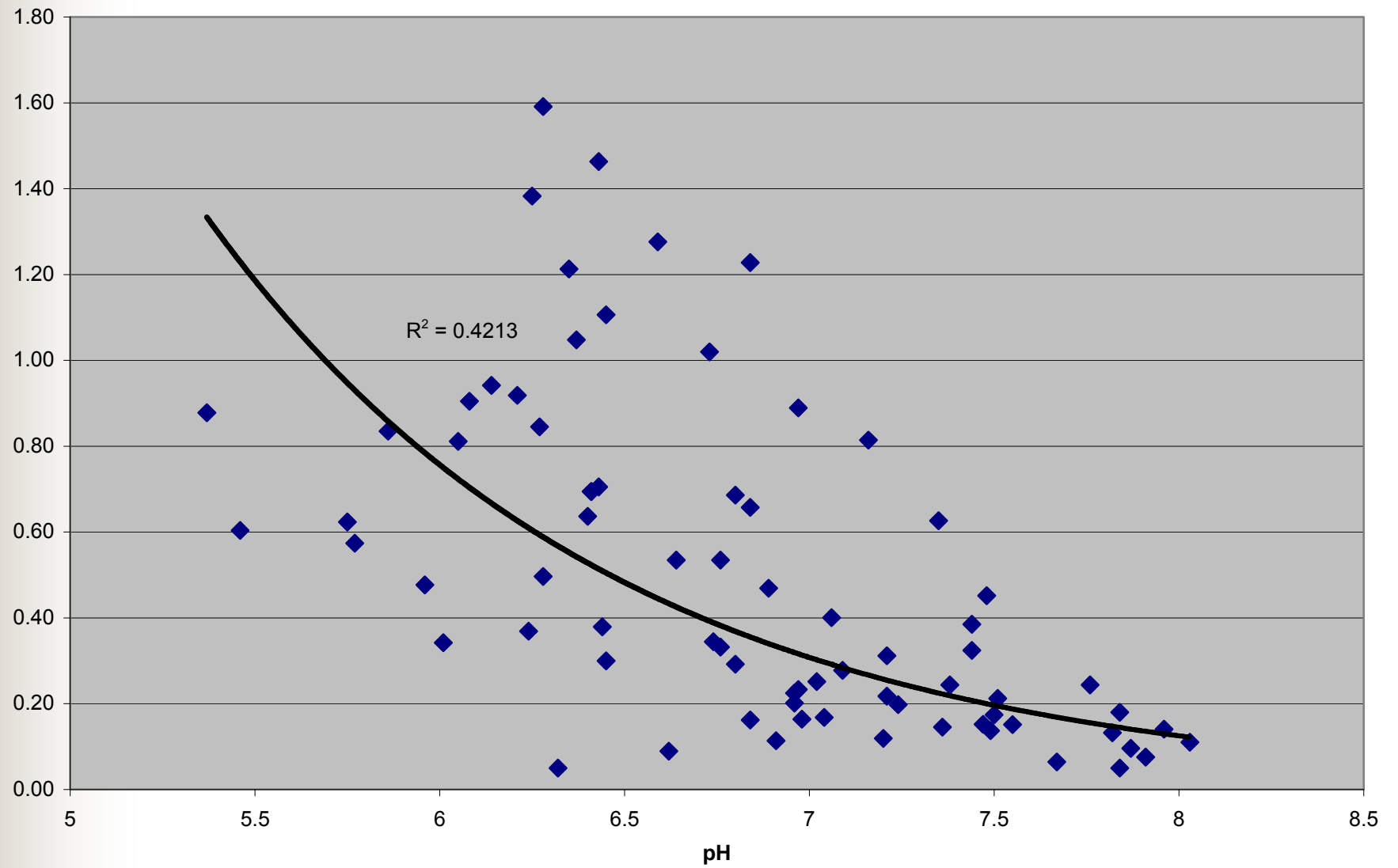
**Average Tissue HG by Tropic Guild**

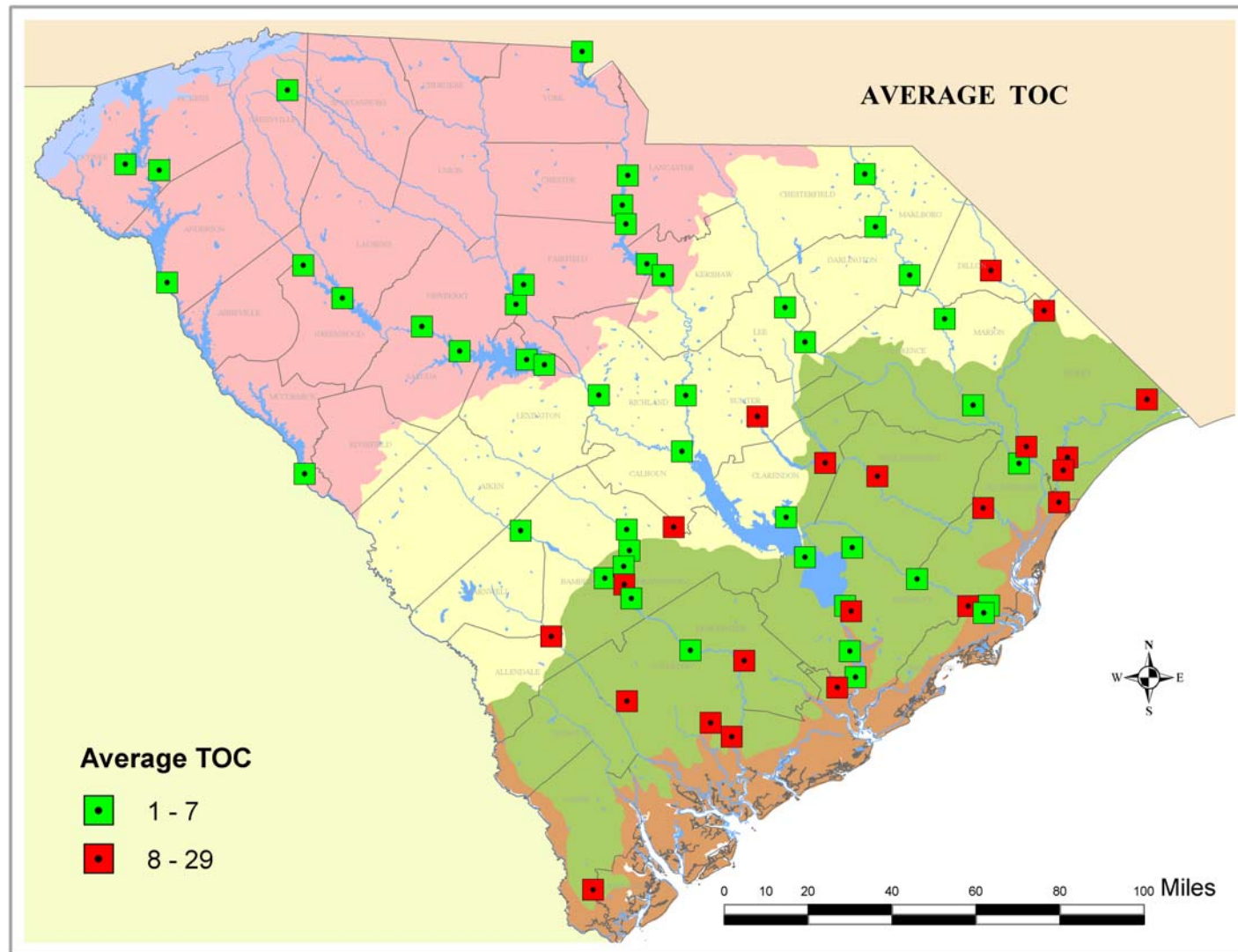




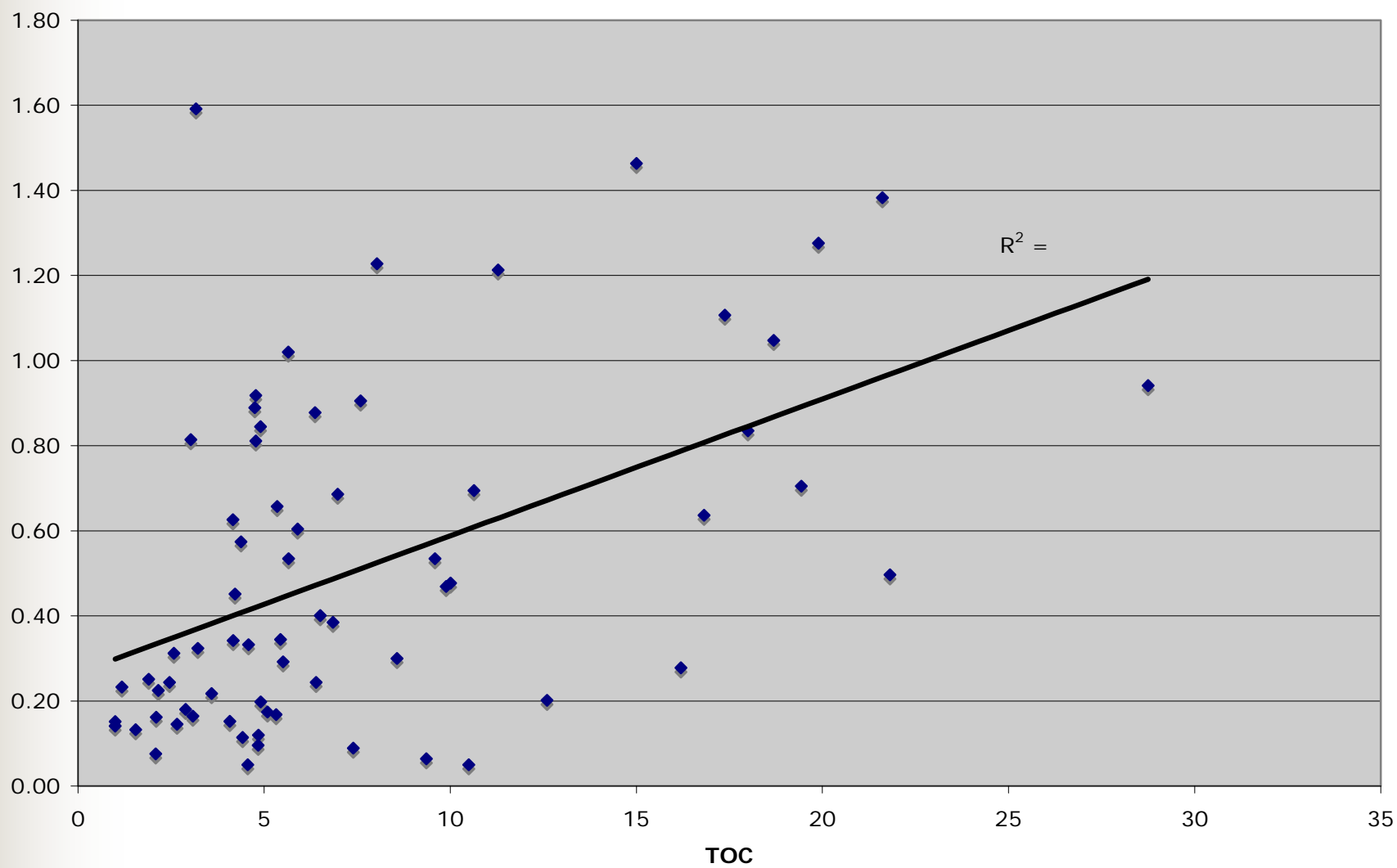


Average Tissue H levels vs pH for Largemouth Bass in South Carolina



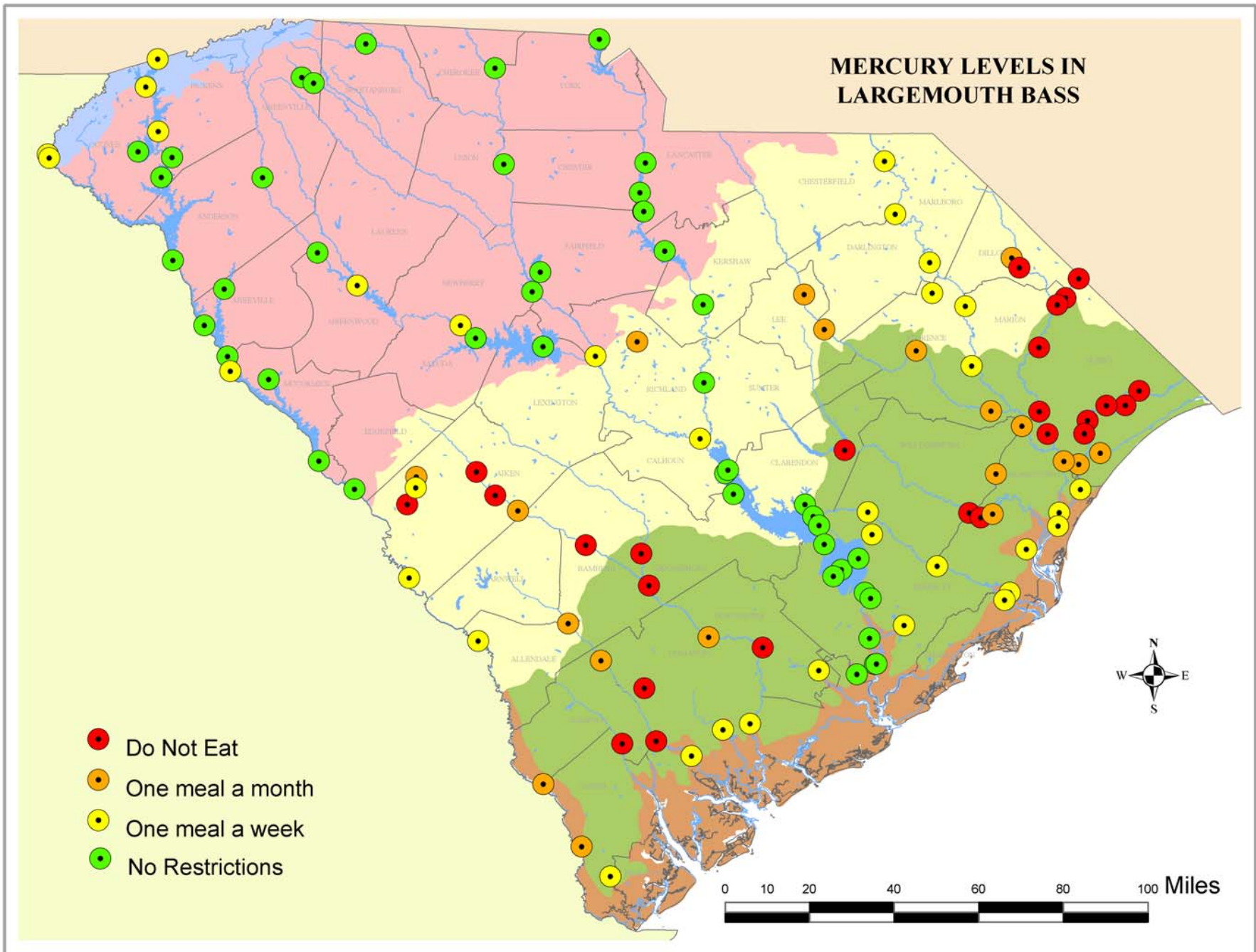
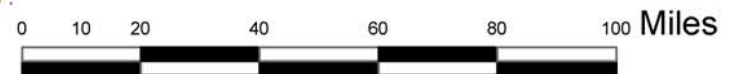


**Average Tissue HG vs TOC for Largemouth Bass in South Carolina**



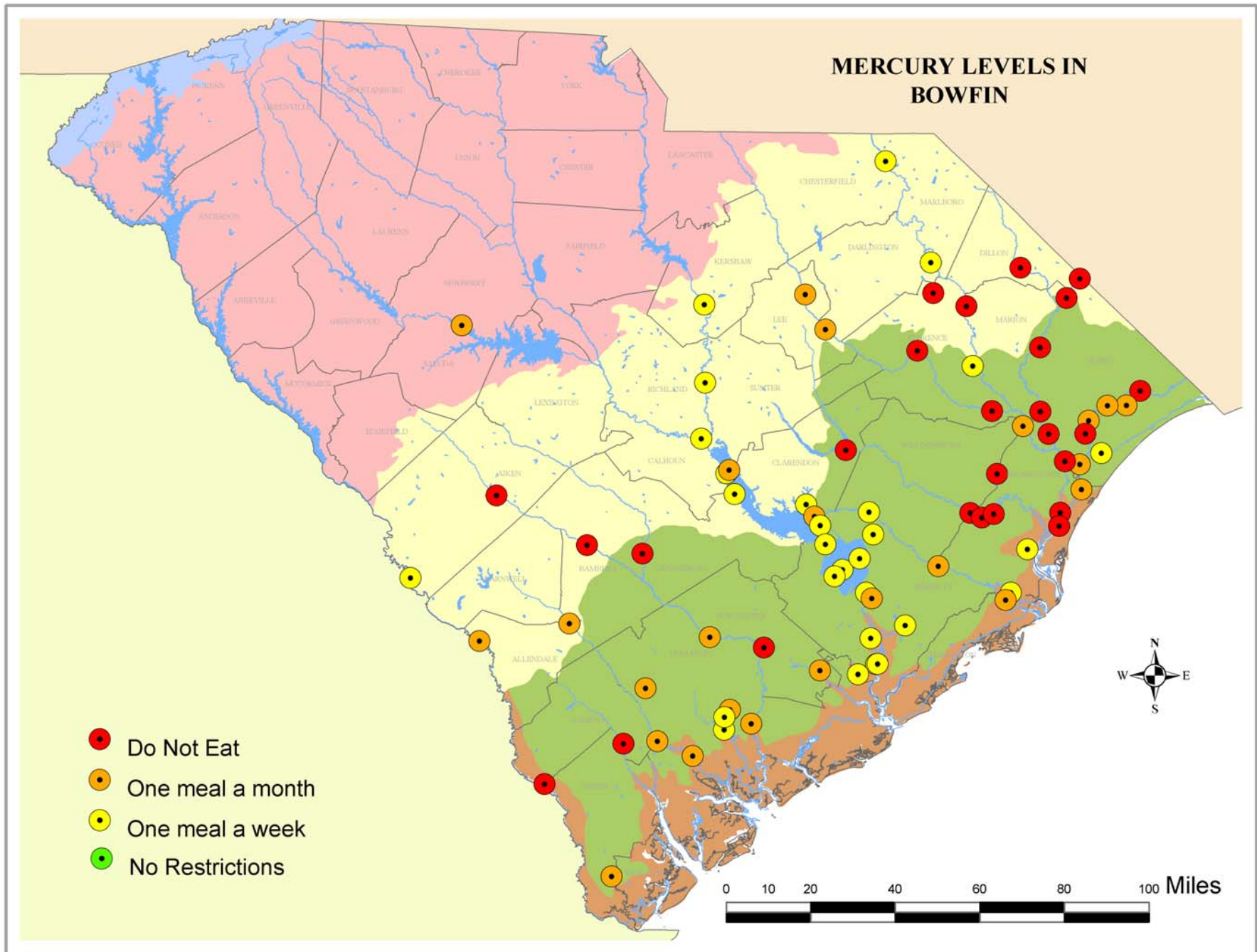
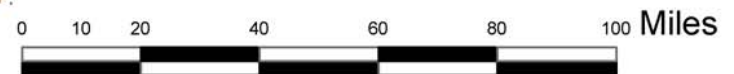
## MERCURY LEVELS IN LARGEMOUTH BASS

- Do Not Eat
- One meal a month
- One meal a week
- No Restrictions



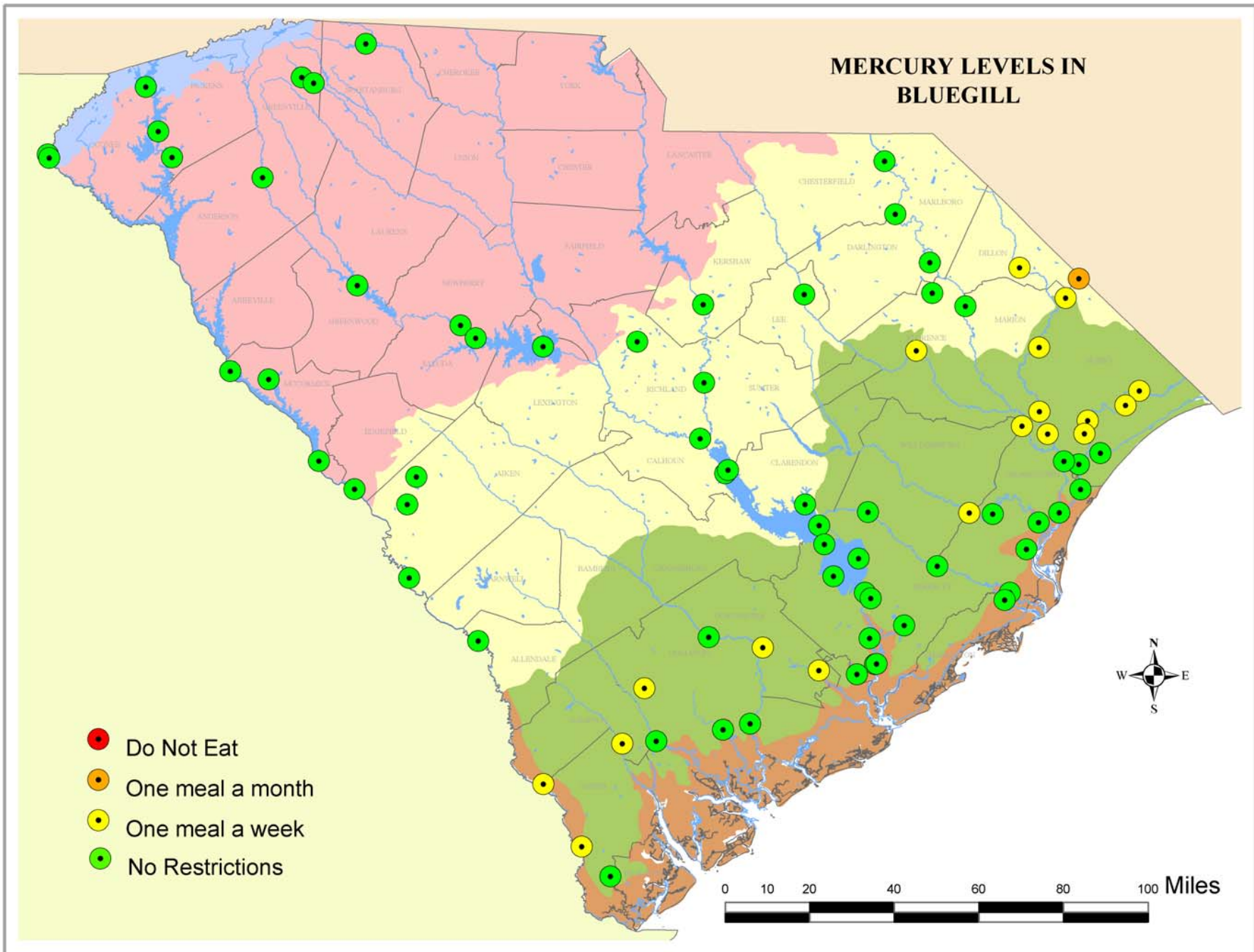
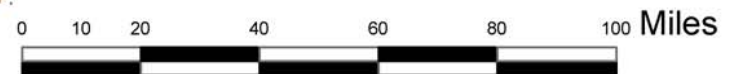
## MERCURY LEVELS IN BOWFIN

- Do Not Eat
- One meal a month
- One meal a week
- No Restrictions

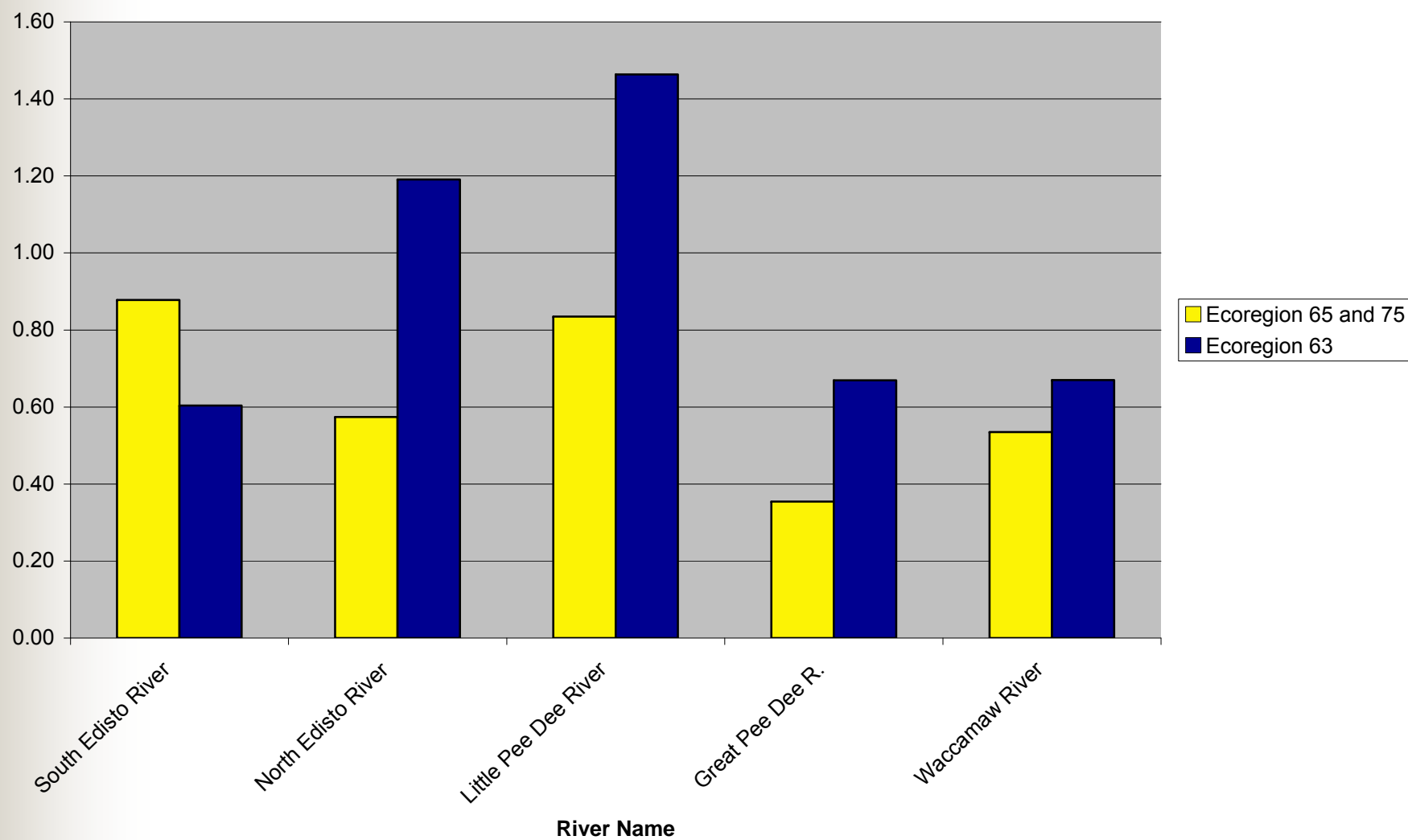



## MERCURY LEVELS IN BLUEGILL

- Do Not Eat
- One meal a month
- One meal a week
- No Restrictions



**Ave HG Tissue Concetrations for Largemouth Bass in SC for Rivers draining two EPA Level III Ecoregions**





Went S. P., 2004. A Statistical Model and National Data Set for Partitioning Fish-Tissue Mercury Concentration Variation Between Spatiotemporal and Sample Characteristic Effects. USGS 2004-5199

■  $\log_e(C_{ijk}+1) = \sum \alpha_k \times \log_e(\text{length}_k+1) + \sum (\beta_j \times \text{event}_j) + \epsilon_{ijk}$

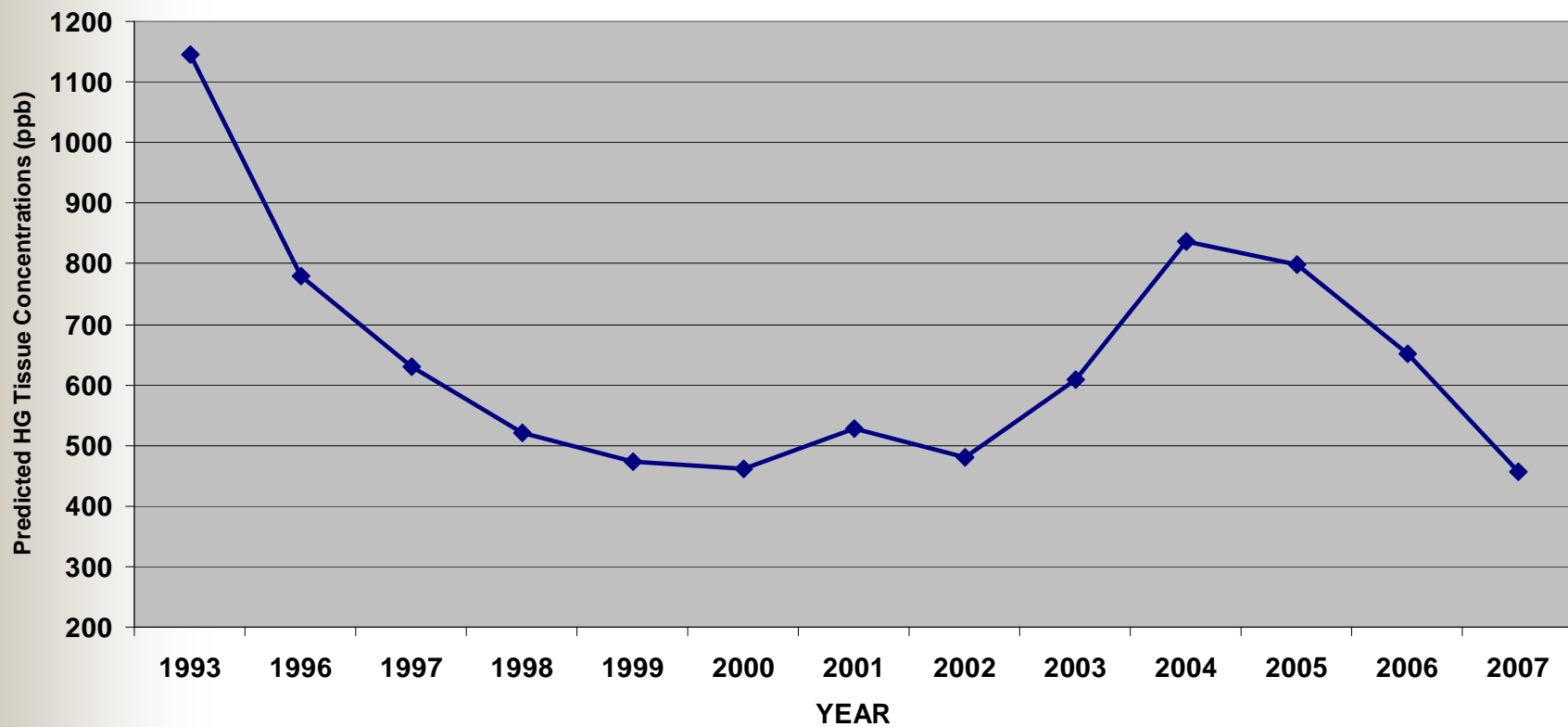
•  $C_{\text{pred}} = e^{(\alpha_k \times \log_e(\text{length}_{\text{pred}} + 1) + \beta_j)} - 1$



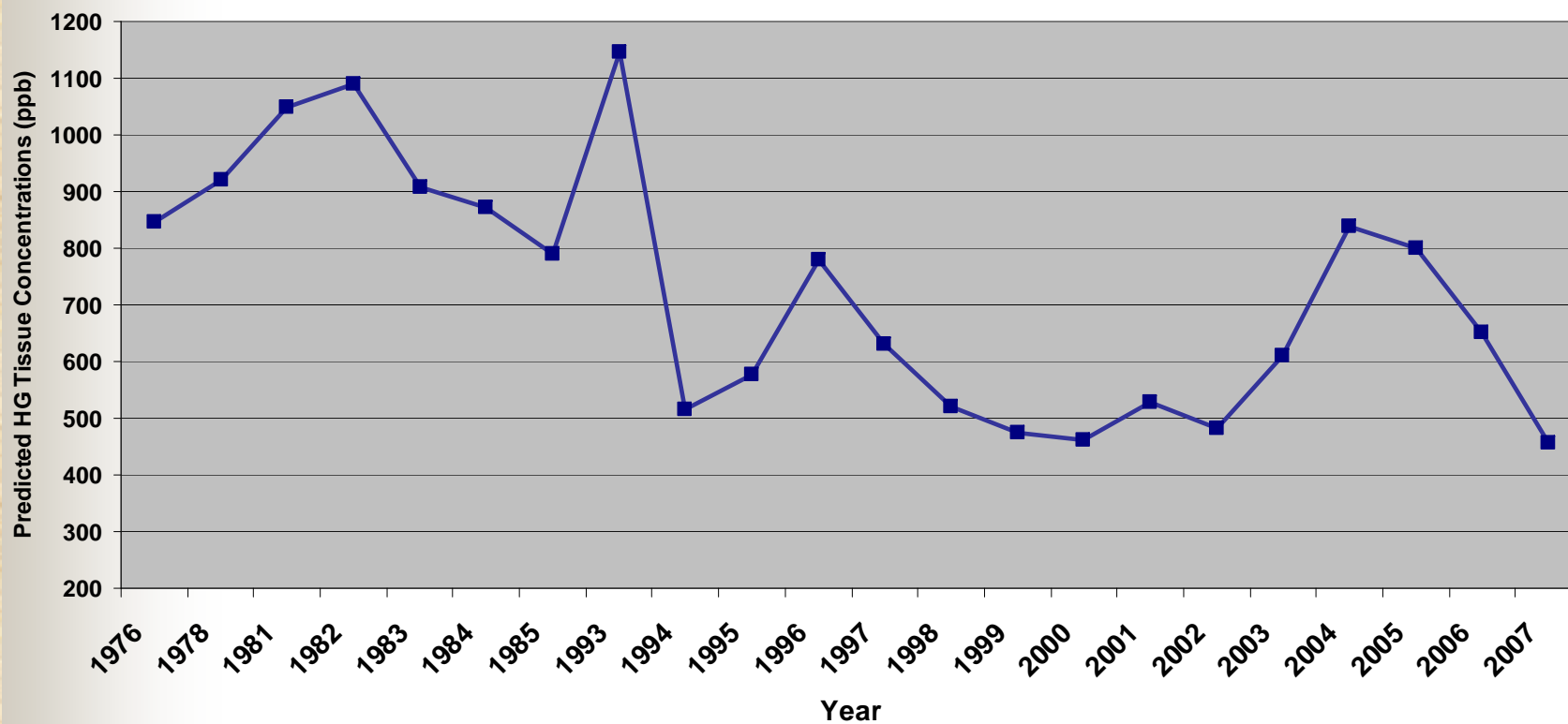
## SC Waters Ranked by Ave. Largemouth Bass HG Tissue Concentrations

Water	Ecoregion	Ave. HG (ppm)
Little Pee Dee	63	1.42
North Edisto	63	1.29
Lumber River	65	1.27
Coosawhatchie	63	1.23
Pocotaligo R.	63	1.22

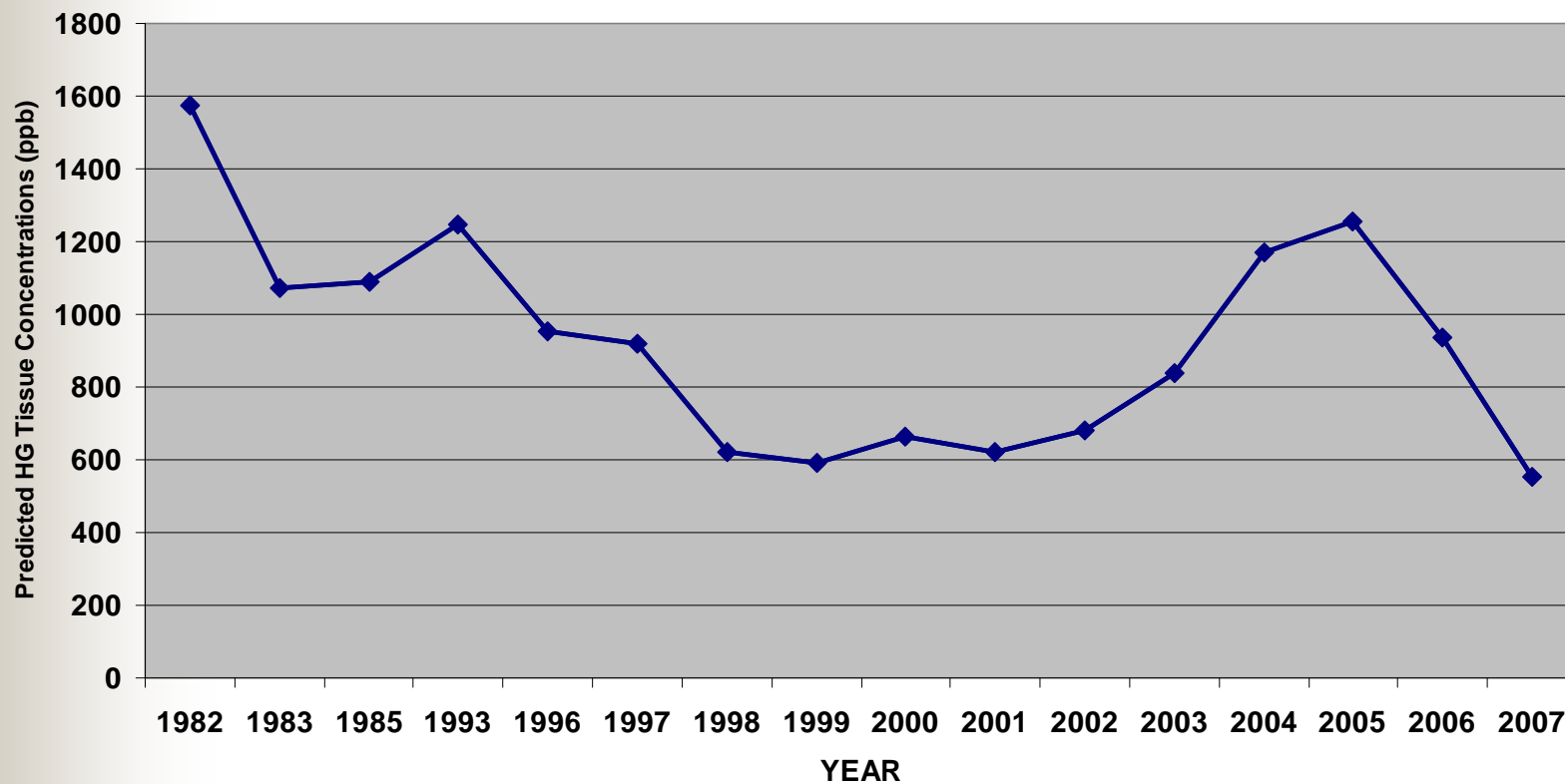
Trend Analysis for Predicted Fish Tissue Mercury for Select Coastal Plain Water Bodies in South Carolina



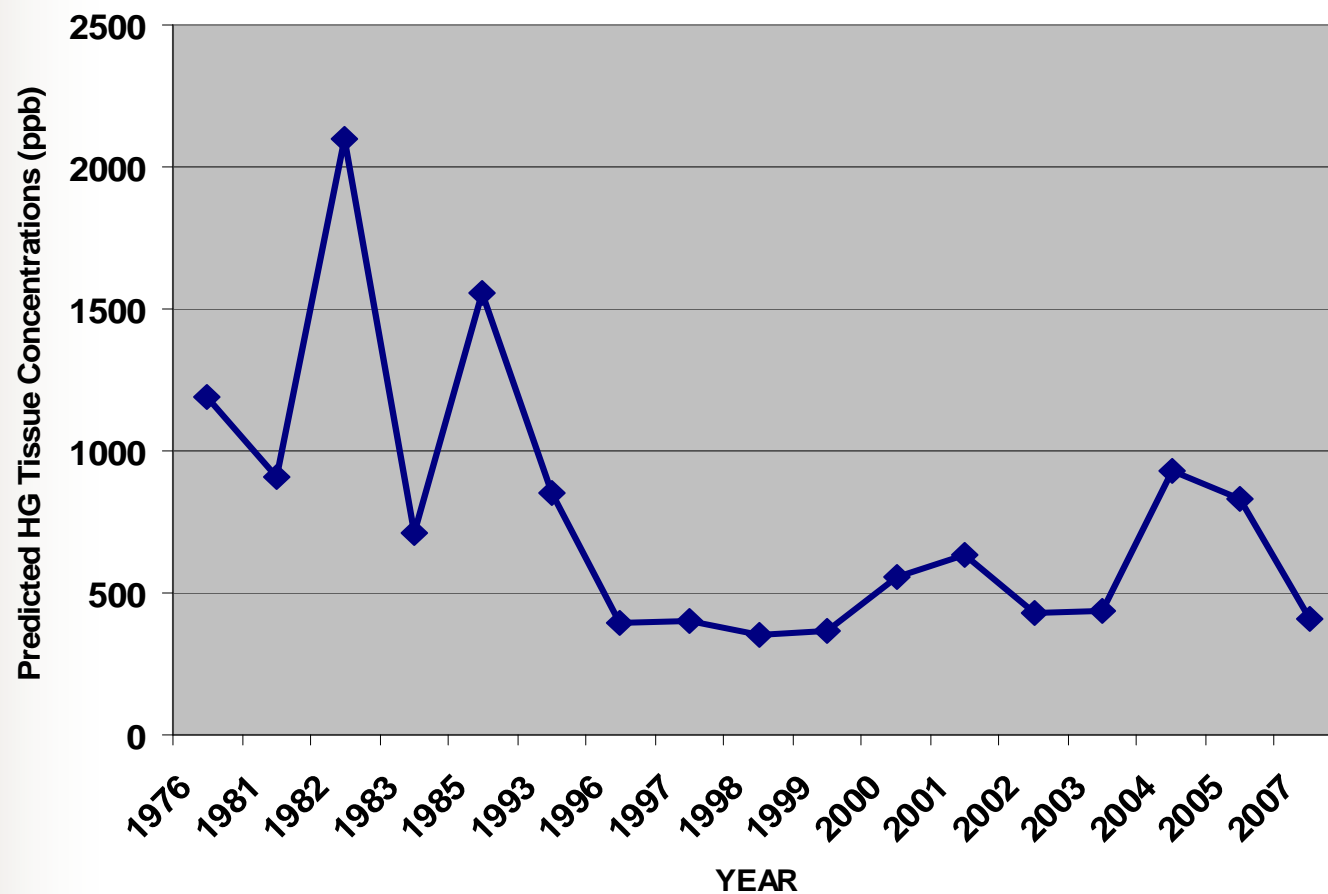
## Trend Analysis for Predicted Fish Tissue Mercury for Coastal Plain Water Bodies in South Carolina



Trend Analysis for Predicted Fish Tissue Mercury for the Edisto River in the Middle Atlantic Coastal Plain Ecoregion of South Carolina

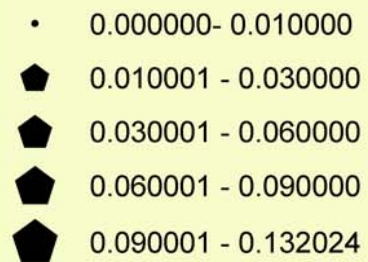


## Trend Analysis for Predicted Fish Tissue Mercury for the Great Pee Dee River in the Middle Atlantic Coastal Plain Ecoregion of South Carolina

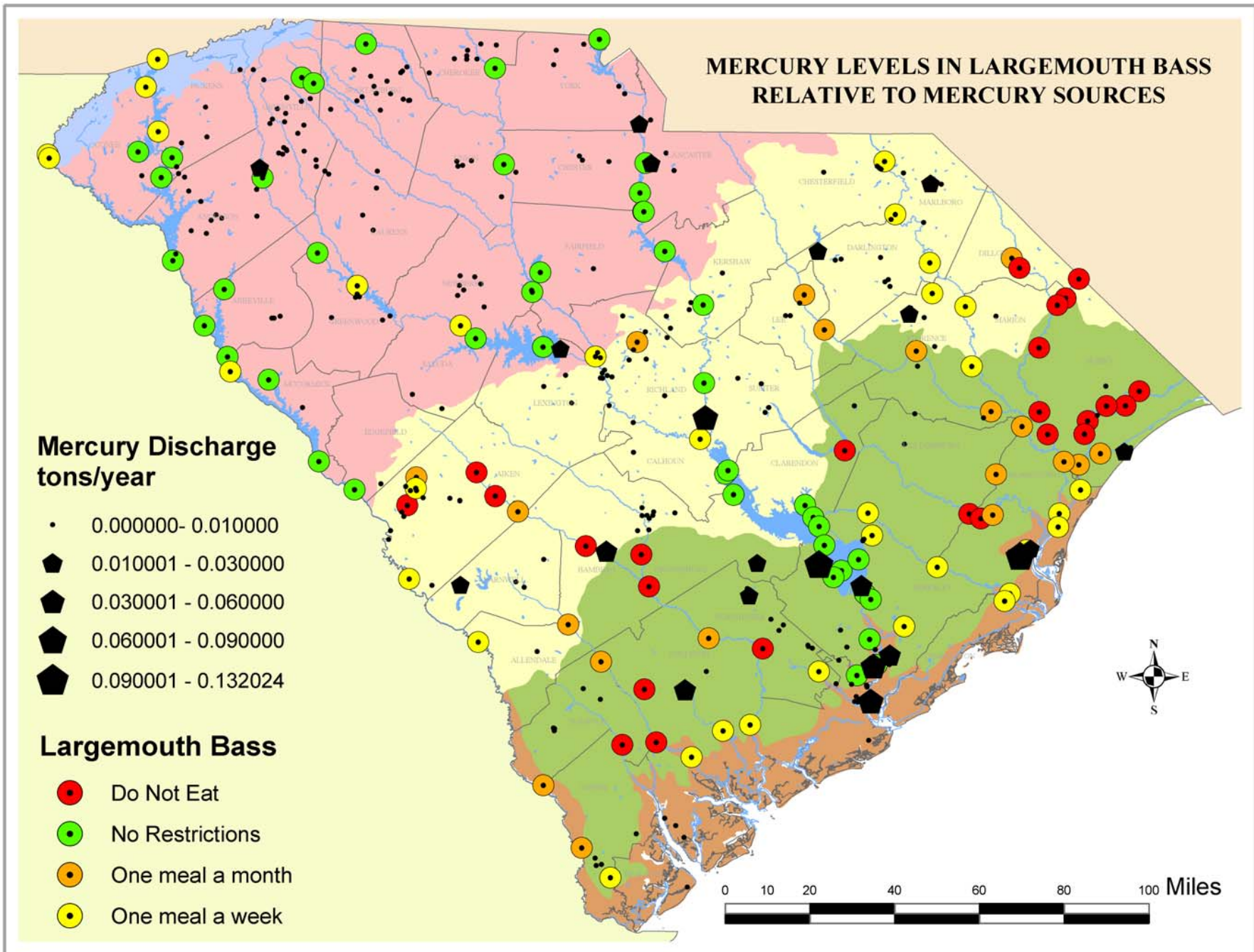
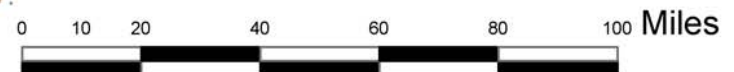
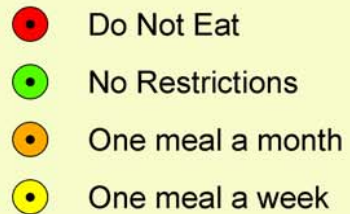


# MERCURY LEVELS IN LARGEMOUTH BASS RELATIVE TO MERCURY SOURCES

## Mercury Discharge tons/year



## Largemouth Bass



**Average Mercury Concentrations in  
Large Mouth Bass In Georgia  
and South Carolina**



- Do Not Eat
- One meal a month
- One meal a week
- No Restrictions

30 15 0 30 60 Miles





# Credits

## Map Makers:

Dr. Jeannie Eidson, GIS  
David Eargle, ABS

## Fish Killers and Shake Makers:

Chad Altman, ABS  
Scott Castleberry, ABS  
Will Dillman, ABS

## Fish Paste Processors:

EQC Laboratories

## Water Quality:

David Graves, WMS  
David Chestnut, WMS

## Data Managers:

Multiple IT Staff

## Outreach:

Ann Marie Johnson et. al.

## Statistical Support:

Dr. Marisa Domino  
UNC School of Public Health

## Former Program Manager:

Butch Younginer

## HG Emissions Map:

Tommy Flynn, AIR

# Mercury in Products



Rodney Wingard

The South Carolina Department of Health  
And Environmental Control





# Thermostat Recycling Corporation

- TRC is a not-for-profit corporation founded and operated by thermostat manufacturing companies.
- TRC facilitates the nationwide collection of all brands of wall-mounted mercury thermostats so that the mercury can be recovered.
- Collection takes place through HVAC wholesale outlets and HVAC contractors (that meet certain size or location criteria) as well as hazardous household waste facilities.



# Thermostat Recycling Corporation

- Participating organizations pay a one-time fee of \$25 to obtain a collection bin.
- All other costs of the program are covered by TRC.
- There are eight participating organizations in South Carolina.
- More information can be found at [www.nema.org/trc](http://www.nema.org/trc) or by calling 1-800-238-8192.



# School Cleanout Program

- Pilot program was conducted to remove elemental mercury and mercury containing equipment from S.C. schools in Fall 2006.
- Fluorescent bulbs and thermostats were excluded from the pilot program.
- Pilot program was conducted in conjunction with the S.C. Department of Education (contact made with school nurses, science chairs and facilities managers).



# School Cleanout Program

- Each participating school provided an inventory of items for pick up.
- DHEC's contractor collected items and ensured that mercury was recovered.
- Overall, 20 schools and school districts participated – resulting in about 40 pounds of mercury being recovered



# Fluorescent Bulbs

- DHEC, S.C. Department of Commerce and USC received a three-year grant from U.S. EPA in 2005 to promote the recycling of fluorescent and other mercury containing bulbs.
- In 2005, direct mail piece sent to more than 1,000 of the largest businesses as well as to all tanning salons in the state.
- In 2006, direct mail piece sent to about 4,000 businesses as well as nearly 900 tanning salons.



# Fluorescent Bulbs

- Worked with a number of schools throughout the state to promote fluorescent bulb recycling
  - Lexington District 2 and Richland District 2 have implemented district-wide programs
- Developed fact sheet, placed information on the Web and helped generators find recycling markets
- Continue to encourage local governments to accept bulbs from residents as part of recycling programs
- Continue to promote bulb recycling through the S.C. Smart Business Recycling Program  
([www.scdhec.gov/smartbusiness](http://www.scdhec.gov/smartbusiness))



# Compact Fluorescent Bulbs (CFLs)

- Worked with S.C. Energy Office and DHEC's Bureau of Air Quality to develop fact sheet on CFL management
- Monitoring national retailer take-back programs through association with the Product Stewardship Institute (Boston, MA)
- In June 2008, The Home Depot began accepting CFLs from consumers in all U.S. stores.
- Other retailers expected to offer programs

# Mercury Switches

- In convenience lights (hood, trunk, doors and vanity mirror)
- In ABS G-force sensors
- In air bag crash sensors
- Cars built prior to 2003
- Other items







# Switches Found In

- Audi
- Daimler Chrysler
- Ford
- General Motors
- Lexus
- Mazda
- Mercedes-Benz
- Mitsubishi
- Nissan
- Porsche
- Subaru
- Toyota
- Volvo



# Why are Switches a Problem?

- Roughly 13.5 million automobiles are recycled annually
- Dismantlers remove parts and flatten
- Scrap recyclers shred
- Steelmakers melt scrap and make new products
- An estimated 67 million switches are available for recovery!



## The S.C. Law

*“No person shall knowingly place an end-of-life vehicle into the production stream for a steel recycling facility in South Carolina containing a mercury switch, as defined in this section.”*

Section 44-96-185



## The Law Continued ...

- Automobile manufacturers (and steelmakers) fund recovery program
- End-of-Life Vehicle Solutions (ELVS) plays key role
- Violators may be subject to a fine



## The Law Continued ...

- Tax credit of \$2.50 per mercury switch collected is available to vehicle recyclers or scrap recycling facilities
  - Corporate income tax (Section 12-6-530)
  - Corporate license fees (Section 12-20-50)
- Signed into effect on May 31, 2006

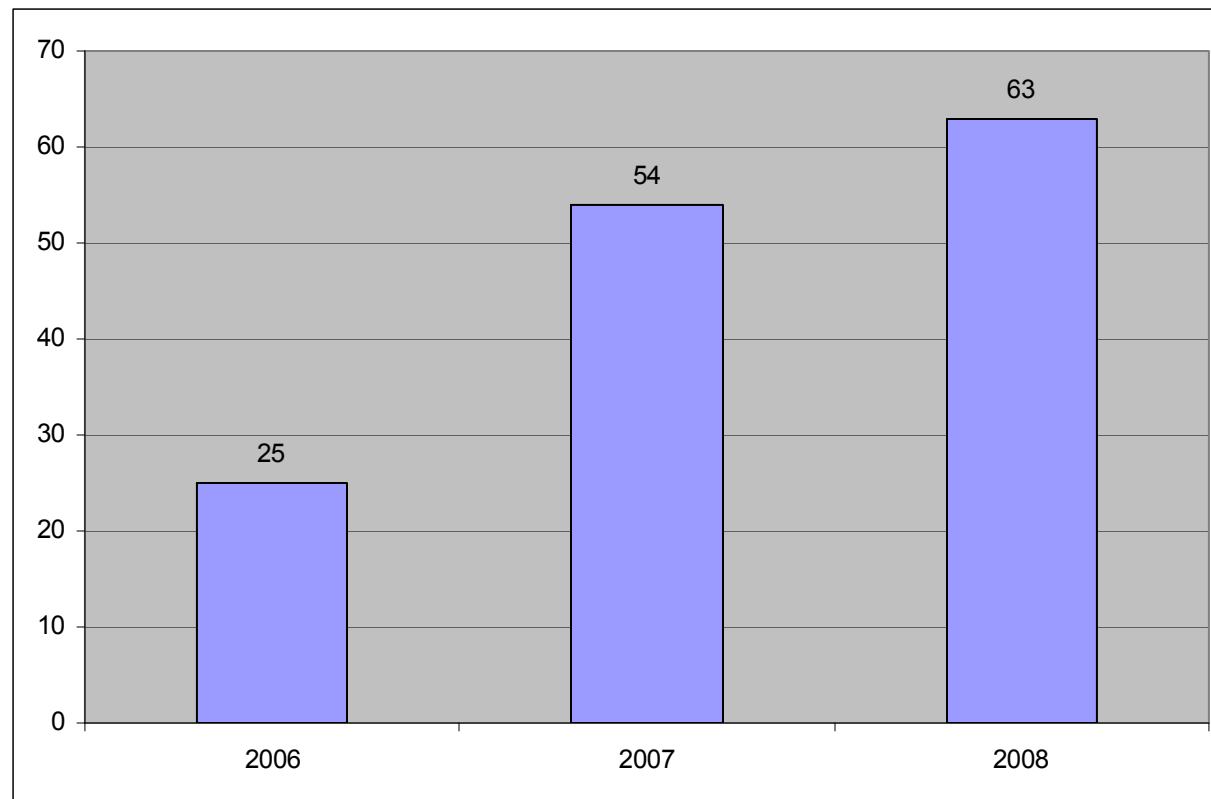


# ELVS Provides

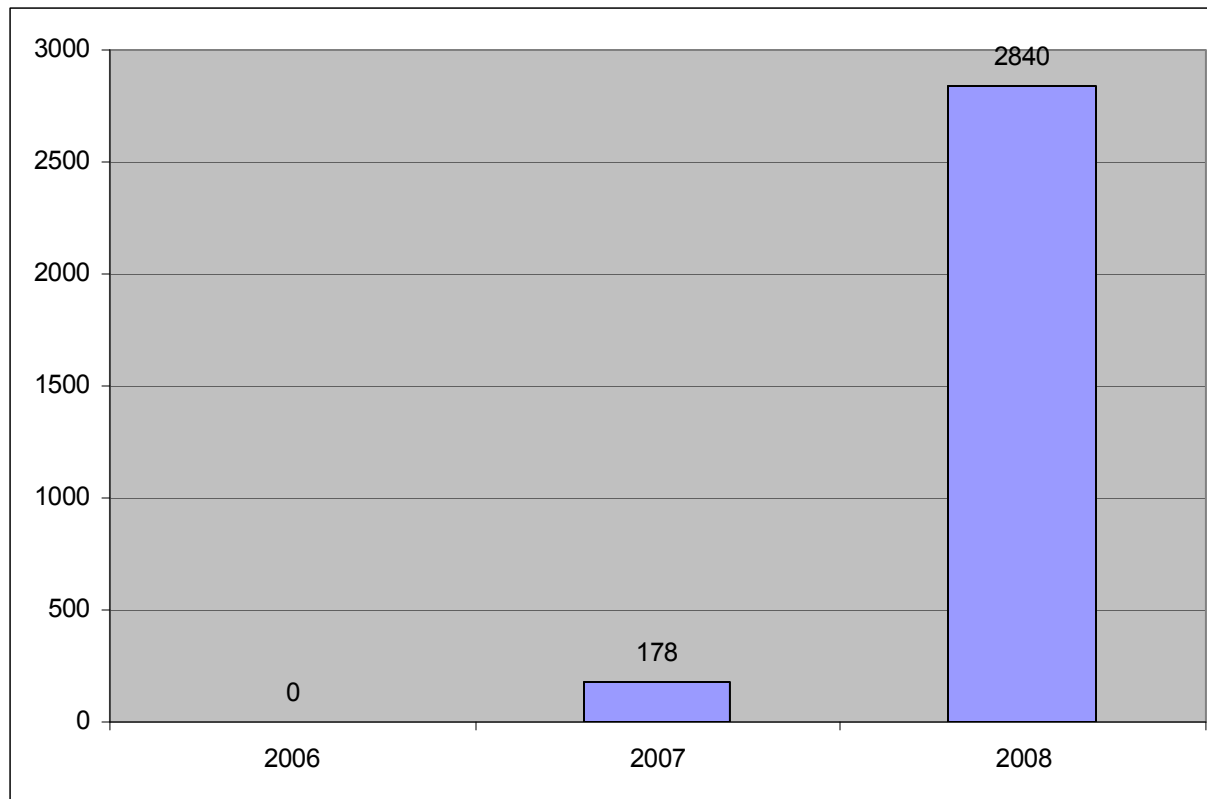
- Educational materials
- Collection buckets
- Switch recycling
- Tracking/reporting



# Number of S.C. Participants

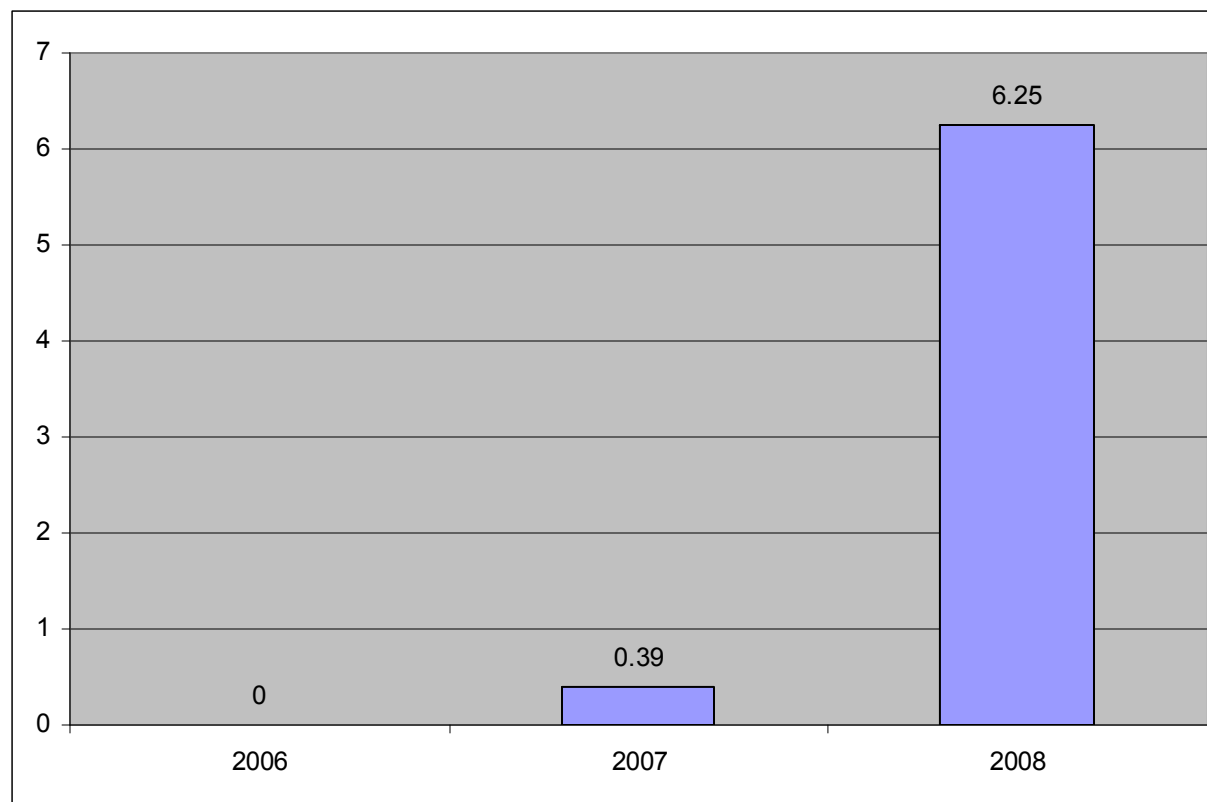


# S.C. Switches Recovered



# Mercury Recovered in S.C.

(in pounds)





# More Information

- End-of-Life Vehicle Solutions
  - [www.elvsolutions.org/](http://www.elvsolutions.org/)
- The Environmental Quality Company
  - [www.eqonline.com/](http://www.eqonline.com/)